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Abstract

American students have continuously performed lower than students from other countries on multiple different standardized tests. New methods of teaching students are needed in order to help American students to develop a deeper understanding of the math curriculum. This article focuses on the impact that using board games as scaffolds has on student goal orientation. It is proposed that implementing the use of board games as scaffolds appropriately, and according to effective scaffold design framework, the games will support mastery goal orientation and a deep understanding of the concepts. Vygotsky's socio-cultural theory of cognitive development supports the research and findings of this study.

Introduction

The field of mathematics is an essential part of today's educational curriculum. Unfortunately, based on different standardized test scores, many students in the United States are failing to meet the national curriculum requirements (Loveless, 2003, p. 41). In fact, past president of the Ohio and the Greater Toledo Council of Mathematics avidly points out that American student have continually scored lower than many different countries on international educational assessments (Brahier, 2013, p. 7). In fact some of the results from international assessments have explained the U.S. math curriculum as "an inch deep and a mile wide." (Brahier, 2013, p. 7). This means that a lot of different concepts are taught within the United States curriculum, but at a surface level. This is a major issue and one of the reasons for low achievement on math assessments. Students need to be able to learn the math content with deep understanding and application (Loveless, 2003, p.41).

Many math educational advocates are arguing that math is the most important subject for students to learn and master. According to Doug Clements, math education expert, "All people benefit from higher levels of mathematical literacy" (Clements, 2003, p. 2). The basic mathematical processes and skills are useful in content areas outside of math. Because students in the United States have had a history of scoring poorly on national and international standardized tests, a great emphasis is now being put on math education. Much effort is being put into reforming and reconstructing the way mathematics is taught across America to improve student learning and support deeper understanding of the content (Brahier, 2013, p. 11).

Developmental psychologist, Lev Vygotsky, found that learning can be seen as a socio-cultural process. In order to teach math more efficiently and to help students formulate a deeper understanding of mathematics, teachers need to adapt the way they teach the content. Teachers

can support social learning constructs by scaffolding the material to help students reach a level of individualized learning. Scaffolds are provided by teachers in order to help the student move from supported, social learning to individualized learning and application.

Board games can be incorporated into the classroom as a scaffold to help students better practice and learn mathematical concepts. Board games that are specific to math education and aligned to the content standards can be extremely beneficial for student learning. This study focuses specifically on the impact of scaffolding through the use of board games on student goal orientation in the classroom. Through the process of playing different board games associated with the specific math concepts being taught, students can interact socially, develop problem solving strategies, and actively learn the math material at a deep level**.**

Literature Review

Scaffolding

Scaffolding is an essential element in the field of education. The idea of scaffolding primarily emerged from the work of the developmental psychologist, Lev Vygotsky. Work by Vygotsky suggests that social interactions positively impact cognitive development in children and adolescents. Scaffolding is the process of guiding and supporting students while learning by providing students with tools and strategies that they will be able to use on their own in the future (Baker, 2006, p. 19).

In addition to scaffolding, Vygotsky also established the concept of the Zone of Proximal Development (ZPD). The ZPD is the instructional level at which a student is able to learn given they are provided additional support. In other words, the ZPD is the level of learning that a student has not met individually, but can meet with extra supports. According to Vygotsky, the ZPD is a critical stage in student learning, as it is the stage in which cognitive development

actually occurs. The ZPD is the level of learning that is between what the student can accomplish individually and what the student can accomplish with support and guidance (O'Donnell, 2012, p. 87). Scaffolding occurs within the Zone of Proximal Development; thus, it is an essential aspect of learning.

Scaffolds need to be personalized for each student. Students do not all learn at the same pace, and do not all need the same amount of support (Fani, 2011, 1551). Effective scaffolds are created to meet the students' learning and motivational needs. As described in "A Framework for Designing Scaffolds that Improve Motivation and Cognition," motivational design is an essential part of developing scaffolds to use in the classroom. By taking motivational design into consideration when creating scaffolds, the scaffolds are more likely to be personalized for students and also support a deep learning of the material. Some of the different motivational frameworks to consider when creating scaffolds include fostering interest, promoting mastery goals, promoting cooperation rather than competition, promoting perception of optimal challenge, and help students to direct their own learning. All of these frameworks play into the students' interest in the content and the overall effectiveness of the scaffold. In addition, by considering these frameworks when creating the scaffolds, student motivation can be increased and the student is more likely to develop a deep understanding of the content (Belland, 250).

Goal Orientation

As students are in the process of learning, they develop mid-sets and goals that are aimed toward the completion of the assigned task. These goals act as motivators for student learning to occur. Because the goals that are developed in student learning are centered on achieving a task, they are called achievement goals. Mastery-oriented and performance-oriented are two types of achievement goals that differ due to the intentions of the goals. Mastery-oriented achievement

goals are developed when a student is focused on establishing a deep understanding and knowledge of the content (Pintrich, 2000, p. 544). In contrast, performance-orientated achievement goals are associated with the student focusing on getting a good grade or being the best at the task (Akin, 2012, p. 237). Typically, performance goal orientation is related to the student learning the material at a surface level because they were focused on the outcome rather than the content (Pintrich, 2000, p. 544).

There has been research that suggests that a student's goal orientation affects the students' attitudes toward the subject. According to Ahmet Akin, author of "Achievement Goal Orientations and Math Attitudes," the students' goal orientation can be sometimes correlated with their attitude toward math. Akin explains that mastery goal orientations in math usually lead to positive attitudes toward mathematics. In contrast, although it is not always the case, performance goal orientations in math can often be associated with negative attitudes toward math. (Akin, 2012, p. 237-238). There are several causes for the negative attitudes. For instance, one reason is that if students are focused on just getting the best grade or mark on work, or always being right, the student will start to feel negatively toward doing the math task. In addition, another reason may be that the person has no interest in the subject but still puts in a lot of effort just to get the correct answer, without actually learning the material (Akin, 2012, p. 244).

Pintrich also supports the views of the different outcomes of the two different goal orientations. He argues that students who are mastery goal orientated will constantly be trying to progress and learn more of the content. These students will be motivated to obtain knowledge through the use of strategies and achievement. In addition, these students will typically have a positive experience and motivation in the subject. Students who are more performance goal

orientated are focused on the overall outcome of the tasks and not learning. These students usually have less motivation and less interest in the subject. (Pintrich, 2000, p. 545). However, these students often exhibit strong self-efficacy because of their high performance levels. Therefore, it is important that teachers emphasize and guide students to developing mastery goal orientations toward math content. Emphasizing mastery of the content will support students learning the content at a deeper level.

Using Board Games as Scaffolds

Several research compilations have expressed that board games can be a great tool to use in the math classroom to support and guide student learning. There is a large variety of commercial board games that can be used to strengthen the students understanding of a particular concept. Some of board games applicable to mathematics education include Connect 4, Battleship, Rummikub, Mastermind, Tangramables, etc (Lach, 2005, p. 174).

Board games act as effective scaffolds in the classroom when student motivation is increased and the content is learned at a deep level rather than at the surface level. There are numerous benefits of incorporating math educational board games as scaffolds into lessons. One advantage of using board games to help students to understand the content is that it supports the constructivist learning model. The constructivist learning model supports the idea that people learn through their personal experiences in a social context. Playing games allow students to interact socially with their classmates. These interactions may include discourse about strategies and problem solving within the game (Vos, 2011, p.129). In addition, the discussion may also include critiques of others' strategies. Also, students are practicing the math skills, in action. Through the board games they are utilizing different math strategies and concepts to play the game; therefore, they are "learning by doing" (Vos, 2011, p. 128).

The kinesthetic aspect of board games can be highly beneficial for students with special needs. Many times these students need to learn the material through multiple outlets in order to master the concepts. Playing games offer students with special needs hands-on, visual, and social modes of interpreting the content (Ke, 2013, p. 227). The experiences from playing board games help students to further develop their own thought processes and actively practice using newly learned skills. “During game play learners can reflect on their actions and they can draw conclusions, adjust their hypotheses and test them again” (Vos, 2011, p. 129).

Using board games as scaffolds also can be used as a tool to motivate and interest students in the mathematical concept or topic that is being taught. If the game playing environment is engaging and sparks student interest, students will be more apt to want to learn the material. As described by Fatima Fadlelmula, "It is generally acknowledged that powerful learning environments advance the adoption of mastery goal orientation” (Fadlelmula, 2010, 861). To enhance student motivation, specific guidelines can be followed when developing scaffolds to aid in the student learning process. When teachers incorporate board games to scaffold mathematical conceptual learning, these guidelines can be followed to ensure that the scaffolds maximize student potential. “A Framework for Designing Scaffolds that Improve Motivation and Cognition” by Belland, Kim and Hannafin describes the guidelines or developing effective scaffolds. Based on this article specifically, playing board games in the classroom fosters student interest and autonomy, promotes mastery goals, encourages shared goals by the students, provides meaningful cognitive choice, highlights controllability of actions, and helps students to direct their own learning (Belland, 2014, p 250-251).

There are a variety of tactics that teachers can use in order to ensure that these particular aspects of creating scaffolds that improve motivation. When students are given a choice in the

game they wish to play, they are able to practice decision making, which supports autonomy in their learning. In addition, it also allows students to choose a game that interests them. If a teacher implements game playing appropriately, they will emphasize the importance of playing the game to learn, rather than to win; thus, supporting the development of mastery goal orientation. In addition, the teacher also should make it clear that every student is working towards a shared goal while playing the games. This goal is to practice using and developing their math skills and understanding. Less emphasis can be put on winning if the teacher allows students to play the games in groups, rather than individually. This way, the students don't feel as personally pressured to win.

Giving the students the option to learn through playing a game also allows students to practice making educated decisions. For instance, while playing the game, the students will have to decide what strategies to use while playing and what math skills they should use to implement the strategies correctly. Through utilizing well thought out choices in the game, the students also will learn that actions have consequences. For instance, if the strategy they implemented wasn't successful, they will learn that they must try a different technique in order to be successful. In other words, the student can control their actions within the game by thinking about each move that they make. Finally, playing board games to learn the content also allows students to direct their own learning. They will utilize different problem solving strategies and deep thought processes to determine how to be successful in the game. The student is "doing" their own exploring and learning, as opposed to simply being taught the material (Belland, 2014, p.250).

Games provide a fun and engaging outlet for students to practice apply math and problem solving skills to different situations. When games are aligned to the content standards that the teacher is teaching, they are even more useful. Once students have had some instruction on the

content, board games are great scaffolds to use to help students develop and strengthen their abilities with the skills. Lach and Sakshaug explain that playing board games gives students the opportunity to repeatedly practice and use specific skills and strategies. Practicing these skills is extremely effective through playing board games because students are "learning by doing" and actively participating in the learning process (Lach, 2004, p. 34).

Other Research in the Field

Utilizing board games as scaffolds in the classroom is not a well-developed field of research; however, there are several in depth studies and articles that are related to the topic. The article "Let's Do Math: Wanna Play" by Tisa Lach and Lynae Sakshaug, is an article describing an action research study about how student learning was affected by playing board games to learn. This study concluded that game playing in mathematics classrooms results in higher motivation and interested student learners (Lach, 2005, p. 171-175).

Another study, "Games for engaged learning of middle school children with special learning needs," focuses on the impact playing games has on the learning of students with special needs. Although this article is focused on playing computer games, rather than board games, it is still relevant to this research. It outlines many pros and cons that board game playing has on the learning of students with special needs. The conclusion of this research is that if games are appropriate and well-developed, the games help to meet the learning needs of students with special needs, and have a positive impact on their learning of the math content (Ke, 2012, p. 225-242).

Another related research study is entitled "The Role of Playing games in Developing Algebraic Reasoning, Spatial Sense, and Problem Solving" by Tisa Lach and Lynae Sakshaug. This article focuses mainly on the impact that playing games has on student development on

these three specific mathematical skills. The overarching finding in this study was that playing board games was very beneficial in the development of these three skills. The study also discussed benefits of playing board games in math classrooms. Besides aiding in math skill development, it was also noted that a major advantage of playing games is that they can also be played in the home by students and their families. If students are really engaged and interested in the game, they will get even more practice with the skills in the home setting (Lach, 2004, 34-42).

These research articles are not the only ones that exist in the field; however, these were all highly relevant to the topic "The Impact of Scaffolding through the use of Board Games on Student Goal Orientation." Overall, most of the articles suggested that board games are highly effective and beneficial scaffolds on student learning. If the board games are aligned with the math material being taught, and the learning environment is cohesive, board games help students develop a deeper understanding of the content and skills associated with the math curriculum.

Purpose of the Study

The purpose of this study is to determine how scaffolding through board games affects student goal orientation. Therefore, this study focused mainly on identifying whether students exhibited mastery goal-orientation or performance goal-orientation while playing math educational board games. As previously explained, math teachers need to expand and alter their teaching methods in order to improve student learning. If found effective, math board games could be used as supplement tools ad scaffolds, in the classroom, that can support a deep level of learning.

Research Questions

The research questions for the study are:

- How can board game playing be adapted to better meet the needs of students and support mastery goal-orientation?
- Can action research be effectively used to make board games successful scaffolds that support mastery goal-orientation?
- Will students exhibit mastery or performance goal orientation while playing board games to support learning?

Participants

Prior to starting the research, a seventh grade teacher was contacted and given an in-depth description of the study and its purpose. She was very interested in the research, and wanted to help in any way that she could. Thus, she found three female students, from her class that wanted to participate in the research study after school hours. A permission slip was sent home with the students to ensure that their parents had an overview of the research that their children would be participating in. Each student had a signed permission slip from their parents.

The participants in this research study were three seventh grade students. These students attended a public school. Before having the students participate in the study, they were given a brief questionnaire that provided background knowledge on their perceptions of mathematics and their background in playing board games in the classroom. The exact answers to the questionnaire can be found in Appendix A, labeled as Questionnaire 1

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Table 1. Background information on students.

	Age	Gender	Parental Marriage Status	Favorite Subject	Do they enjoy math?	Have they played games in classes?
Student 1	13	Female	Married	Science	Indifferent	Yes
Student 2	12	Female	Divorced	Social Studies	No	No
Student 3	13	Female	Married	Social Studies	No	No

Methods

Research Design: Action Research

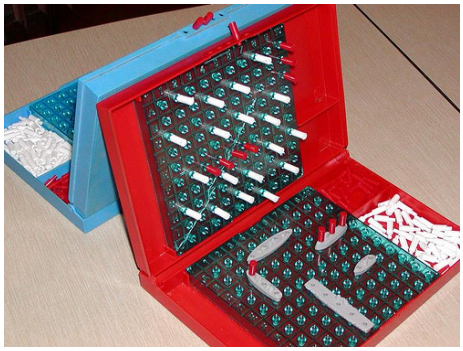
Action research was used during this study. This type of research involves "iterative cycle of problem identification, diagnosis, planning intervention, and evaluation of the outcomes to estimate what has been achieved and to plan subsequent interventions," (Bargal, 2008, p.17). In other words, an action is observed. Then, the experimenter identifies problems or points of improvement for the action. Next, the experimenter develops a plan to alter the action so that it is more successful. Finally, after all interventions are put into play, the experimenter evaluates the success of the changes. In this particular study, action research was conducted to evaluate the impact that playing board games has on student goal orientation when they are used as scaffolds to help students further develop their mathematical skills.

Research Procedure

This study was conducted throughout three different trials. Each trial built on the observations and results from the previous trial. The first trial, acted as the starting point in the research. Prior to the beginning of the trial, the experimenter planned the way that the game was going to be administered. This trial included a simplistic set-up. The game that was chosen to be played was Rummikub. This game was aligned with the seventh grade mathematical practices;

therefore, it could act as a scaffold for developing strategies and using problem solving techniques. Rummikub is a game about strategy and recognizing patterns and sequences. Each player is given 11 tiles, each with a colored number on the tile. The rules of the game indicate that in order to discard tiles, the player has to identify a pattern using their tiles or a mixture of their tiles and tiles that have been laid. The rules of the game explain the patterns that should be used. The patterns are: a sequence of three or four tiles with all different colors and the same number, or three or four tiles with the same color and consecutive numbers. The object of the game is to be the player to discard all of their tiles. None of the three students had played this game prior to this experience. The students were told the rules. The experimenter demonstrated some samples of patterns that were acceptable. Then, the students began to play the game. During the time in which the students were playing, notes and observations were recorded. The students were then asked several questions about their experiences that would be used to adapt the game playing in the next trial. The Questionnaire 2 can be found in Appendix A.

The observations and results from the first trial were used to make alterations to the game set up. These alterations were made in order to make the game playing a more successful scaffold. The games and game playing techniques had to be adapted to meet the needs of the students. For the second trial, a variety of three different game options was presented to the students. This was done so that students could choose a game that interested them or one that they may have had previous experiences with. Another alteration that was made during this trial was that the teacher/ experimenter joined in on the game playing experience. The last alteration during this trial was that the students would play the game in partners, as opposed to



individually. The student chose to play Battleship, which they had all previously played. This game was aligned with the 7th grade math standards, and is intended to help students learn how to use coordinates and locate points on a coordinate plane. During the game playing, notes and observations were taken. In addition, the students were asked several questions that would help guide in making further alterations of the game playing. Questionnaire 3 can be found in Appendix A.

To start out the third trial day, the students were again presented with the two games that were played in the previous trials (Rummikub and Battleship). The students were told that each of the games would be played; but, they would get the choice of which one that we were going to play first. The students chose to play Battleship first. Another change in the game playing was giving the students the option of playing on their own, or having the instructor participate also. They chose to have the instructor participate. They also chose to play in partners again. The final adjustment to this game was adjusting the difficulty level. The letters were covered on the Battleship boards, and replaced with number stickers. Therefore, students had to use true (x,y) coordinates. The proper way to say (x,y) coordinates was quickly reviewed, and the students began to play. While the game was being played, notes and observations were recorded.

When the game was complete, the students set up the next game, Rummikub. They were told that there was also going to be a spin on the original game. The twist to the game increased the difficulty level of the game. The students would be creating the “rules” or patterns that had to be met in order to discard tiles. Before starting the game, the students chose three patterns to use in the game. The patterns that the students chose to play by were: every other number where

color doesn't matter (ex. 1,3,5,7...), two of the same number with two of the same of another number, where color doesn't matter (ex. 1,1,2,2) and ordered sequence of all the same color (1,2,3,4). The observations about student game play were recorded. Finally, the students completed a post-study questionnaire about the game playing and what they had learned throughout the study. Questionnaire 4 is located in Appendix A.

All of the data was collected through questionnaires and observations. During the game play, field notes were taken. These notes kept track of relevant comments students made, the emotions they were exhibiting, and how they interacted with the other participants. The questionnaires that were given to the students were prepared prior to each trial. These included questions that provided information about the students' math experiences and questions that would help make the game playing more successful for learning.

Results

There were several prominent trends that were found throughout the study. Several deductions could be made based on the students' comments, actions, and responses throughout the study.

Adapting Game Play and Goal Orientation

Overall, it was found that adapting game play was critical in using board games as scaffolds. The adaptations were made to support student comfort in the learning environment, difficulty of the game, and autonomy.

Trial 1

Again, this trial focused on students being observed playing a board game that was chosen by the experimenter. While playing the game, Rummikub, the students were quiet and hesitant to identify the patterns. There was not much conversation. In fact, in the experimenter's

journal, it was recorded that, "At the beginning of the game, students see apprehensive. They are not discussing anything and appear that they do not want to discard a sequence that is incorrect." As the experimenter noted the students seemed shy and showed confusion, it was explained that the first game would only count as a practice game. Then, the students seemed to discuss how they were creating sequences together. *Table 2* includes different comments that were recorded during the trial.

Table 2. Notable Observations and Student Comments During Trial 1

Comments Made by Students	**Students Attitudes and Behaviors**	**Observations**	**Goal Orientation**
"This is hard!"	Apprehensive	Students did not want to lay down an incorrect sequence.	
"I don't know if mine is right."	Shy	At the beginning of the game, students were very worried about being correct.	Performance goal orientation
"That's not right. Maybe you should try making a sequence like this."	Hesitant	After knowing the game was just "practice," students began to discuss and critique others	

It was decided that students primarily exhibited performance goal-orientation, as they seemed to be overly meticulous about not making mistakes. When the trial was complete, the students completed a questionnaire. Questionnaire 3 is located in Appendix A.

Trial 2

Trial two included three major alterations to the game implementation. These alterations were allowing the students to choose the game, the instructor participating in the game, and allowing students to play the games in pairs. Based on these alterations, the overall game play differed to that of the first trial. It was noted that the students were more excited about the game

and interested in playing it. In addition, the students had a lot more conversation with their teammates and opponents about the game and the strategies that they were using to play the game. It was recorded that one student said "It is important to say the point right, because if you don't the other person may think that you are talking about a different place on the grid. This indicated that they knew the importance of reading coordinates in the correct order. *Table 3* indicates the prominent results of Trial 2.

Table 3. Notable Observations and Student Comments During Trial 2

Comments Made by Students	**Students Attitudes and Behaviors**	**Observations**	**Goal Orientation**
"I love this game!"	Excited	Students showed that they were interested in the game	
"Where do you think the best place is to put our ship on the grid?"	More Talkative	Students discussed their strategies and how they were going to place the ships on their grid.	Mastery goal orientation
"How exactly are we supposed to read the point we are guessing?"	Open-minded	They were interested in developing the skill of reading points on a coordinate plane because they had to use it in order to place their guess.	

The results of the second trial indicate that students had a mindset of mastery goal orientation. The students were asking questions about the math concepts related to the game, and able to explain the importance of the processes that they were completing. The results of the Questionnaire 3, which is related to trial 2, are in Appendix A.

Trial 3

A combination of the results from the second and first trials were used to determine what alterations needed to be made to the set-up of the game play in order to further support mastery goal orientation and a deep understanding of the content. The changes to the game play were

giving students the option to choose the game and whether or not the instructor would participate, and adjusting the difficulty level of the game. During this trial, students were very talkative and excited about playing the games. They discussed how to properly use the strategies and concepts in the games. Table 4 includes the results of this trial.

Table 4. Notable Observations and Student Comments During Trial 3

Comments Made by Students	Students Attitudes and Behaviors	Observations	Goal Orientation
"How will we be able to say the correct point if we are using a number for the x axis and a number for the y axis? (About Battleship)	Excited	At first, students thought the games were going to be much more difficult with the "twists." Once the students practiced the new rules, they seemed comfortable.	
"Reading the points with numbers is not that hard!" "This is fun!"	Talkative	Students critiqued one another. If they noticed someone made a mistake, they would identify the mistake and discuss how the person could fix the mistake.	Mastery goal orientation
"Let's make up patterns that are all different." (About Rummikub).	Interested/ engaged	Students had fun making their own patterns and rules to the game.	
"I think that your play would be right if you changed the order you have the 2 and 4 in."		Students did not seem to care about winning. They all worked together as a team, even though they were opponents.	

The results of the third trial were very supportive of the development of a mastery-goal orientation. The participants showed that they were more interested in learning how to play the game and use the necessary skills correctly rather than winning. They all played cooperatively and were very respectful of each other. The final questionnaire discussing the third trial and the students' feelings toward the study is Questionnaire 4 in Appendix A.

Therefore, most of the results indicated that when the learning environment makes students feel comfortable, the game implementation allows students to make choices, and the difficulty of the game matches the students' learning ability, mastery goal orientation will be developed. When the environment was not comfortable for students and the needs of the students were not met, they exhibited performance goal-orientation.

Action Research

Overall, the results of the action research were successful. This method of research proved that it could be used to make playing board games appropriate and successful scaffolds in student learning. The action research method resulted in altering the game implementation to better suit the students; thus, resulting in successful game play.

Discussion

Adapting Game Play

One of the main findings of this research is that it is essential to ensure that the environment that the students are playing the game in is both a safe and comfortable learning environment. In the study, when the students felt uncomfortable, they appeared to be retracted and hesitant in playing the game. They were focused more on their performance, rather than learning the material and practicing their skills. When students were hesitant to play, they seemed to have a performance goal-orientation mindset, as they were conscientious of being wrong in the game. In order to make the students more comfortable in playing, the "teacher" became part of the game and students were able to play in partners. Therefore, less pressure was put on each individual.

It was also found that when students had a choice in the game that they were going to play, they had more interest and discourse relating to the overarching math content and skills

associated with the game. By giving the students a sense of autonomy by choosing the game they wanted to participate in, they were able to choose a game that interested them or that they may have had previous experience playing. The students seemed much more interested and excited to play the game! As described by Belland, choice is a big part of creating an engaging scaffold. As long as the "choices are not so numerous as to provoke anxiety among the students," the choices will promote autonomy (Belland, 2014, p. 251).

When students were comfortable in the game playing setting, valuable discourse occurred. The students discussed their strategies and compared them to one another's. Additionally, students exhibited private speech, or spoken aloud thought during the activity. They also implemented and critiqued the problem solving skills that were being used throughout the game. For instance, some of the problem solving skills the students utilized were guess and check and looking at the problem from multiple perspectives. The communication between the students was vital in the students' development of strategies. Additionally, once the students started working in groups, even more valuable discourse took place. According to Belland, Kim, and Hannafin, "If students are working in groups, different members of the same group can have different interests; in this case, it is necessary for groupmates to negotiate a problem aspect that can serve all of their interests," (Belland, 2014, p. 251). Therefore group game playing aided in the discussion, which led to a deeper understanding of the content.

A similar finding was established by Lach and Scakshaug. They found that as the children played the game, they became more interested and engaged in discussing the strategies that were being implemented. Lach explains that the students were "able to develop their own strategies, based on those she had borrowed from others in the group" (Lach, 2005, p. 175). The

discussion among students is a vital part of the board games being used to scaffold learning. Both Piaget's and Vygotsky's theories support this finding.

Piaget's theory indicates that the role of peers is to "stimulate cognitive conflict so as to create disequilibrium" (O'Donnell, 2012, p. 92). This was exhibited when students made comments critiquing and comparing the strategies being used throughout the game play. Vygotskian theories place the peer as "a mentor and guide in much the same ways as a teacher" (O'Donnell, 2012, p. 92). When students explained their thought processes and reasoning to their teammates and opponents, they were giving them a different perspective to look at the problem. This aided immensely in students' developing their own strategies, as previously described.

The final prominent finding was that when board games were adapted to meet the learning levels of the students, the students had more discussion and demonstrated that they had developed a deep understanding of the material. Scott Nicholson states that it is essential to make sure that when using a board game in the classroom, the game matches the abilities of the students. It has to be the perfect difficulty level to maximize learning (Nicholson, 2011, p. 62).

Action Research

Throughout this study, action research appeared to be highly advantageous. By adapting the game playing to meet the students' interests and needs, a deep learning of the content was supported. Although some results are original, many of the findings are parallel to multiple other studies within the same field of research.

Scaffolds need to meet the needs of the students. (Fani, 2011, p. 1551). Therefore, the adaptations made through action research in this study, may not be effective adaptations for board game playing in all classrooms. Teachers can use this study to recognize how action

research is successful in changing the way board games are used in the classroom to promote mastery goal-orientation.

Action research provides the teacher with feedback that is highly useful in learning about methods that are effective for a specific student, or group of students. The feedback can be used to form more meaningful instructional strategies to support student learning (Bargal, 2008, p. 20).

Goal Orientation

The way that teachers design scaffolds to help students learn have an effect on student goal orientation (Belland, 2014, p. 224). In this study, certain adaptations supported performance-goal orientation, while others supported mastery-goal orientation. It was found that when the scaffolds were adapted to meet the students motivational needs, as described by Belland (Belland, 2014, 250-251), mastery goal-orientation was exhibited through the students' behavior, comments, and interactions with each other during the game play.

Therefore, when using game play in the classroom to scaffold student learning in mathematics, it is essential to make sure that the students' motivational needs are being met. In this particular study, the needs that were met were making the students feel comfortable in the environment, meeting the students' ability levels, and sparking student interest. These needs may not be the same for all students and classes.

Conclusions

As the games were adapted throughout the study, students seemed to be developing mastery goal orientation. When the environment of the classroom encourages learning and is a comfortable and safe place to learn, the use of board games is most effective. In addition, it is essential that the games are adjusted to meet all of the needs of students. In this study, when the

game playing conditions were appropriate, students were able to explain the reasoning and logic that was being used behind the moves that they made within the games. This scaffold helped students construct their own thought processes by comparing their reasoning to that of their teammates and opponents.

Limitations

There were some limitations to this study. There were only three participants in the study; therefore, due to a small sample size, the generalizations about the results may not hold true. In order to increase the validity of the results, this study could be done with a larger sample size. In addition, another limitation to the study was that only three trials were held. Although the three trials did show significant results, the results and conclusions would be more valid if more trials were completed with different board games. Despite the limitations, the study did show that action research can help in developing successful board game implementation to scaffold student learning at a deep level.

Implementations for Future Educators

Board games are great tools for teachers to utilize in the classroom to support student learning; however, the teacher must ensure that the games are both appropriate and aligned to the content standards in order for them to be most effective for students. Based on this study, teachers can use action research to adapt the conditions of playing board in order to maximize student learning. The teacher can follow the framework for developing effective scaffolds by keeping students' needs and motivation in mind when creating the scaffold.

Future Studies

There are several future studies that could be conducted to further research over the topic. Another study could focus on the impact that age has on student goal orientation when using

board games to scaffold learning. In other words, this study would look specifically at if there is a change in goal-orientation with age. Another future study to further research in the topic would be to look specifically at the use of board games to scaffold learning in subjects other than mathematics. This would determine if board games could be used as effective scaffolds across the curriculum.

Appendix A

Questionnaire 1:

- **What is your favorite subject?**
  - **Student 1**: Science because I like doing experiments.
  - **Student 2**: Social Studies. I like history and I love my teacher.
  - **Student 3**: Social Studies is my favorite because I like learning about all the events that occurred in the past.
- **Do you like math? Why or why not?**
  - **Student 1**: Math is okay. It isn't my favorite subject, but not my least favorite. I like when I can figure the math out, but I do not like when we have to do a lot of problems.
  - **Student 2**: I don't really like math. It is very hard for me to focus and do good in the class.
  - **Student 3**: I don't like math class because I have not had good math teachers.
- **Have you ever played games in any of your math classes?**
  - **Student 1**: Not recently. I think we used to play them in 3rd or 4th grade.
  - **Student 2**: I can't remember if we have or not.
  - **Student 3**: I haven't played a lot of games in my math classes.

Questionnaire 2:

- **Did you like the game Rummikub? Why or why not?**
  - **Student 1:** I liked this game. I had never played it before, but I thought it was fun. It was kind of hard to come up with sequences made from the tiles that I had.
  - **Student 2:** This game was alright. I felt like I actually had to think a lot during this game. It helped when we did a practice round so I could better understand the rules.
  - **Student 3:** I really like this game! I like making patterns and it was cool to do this with the numbers and colors that were on my tiles.
- **Did you feel comfortable playing this game? Why or why not?**
  - **Student 1:** Yes. I felt comfortable playing this game because I was playing with two of my classmates.
  - **Student 2:** I felt kind of comfortable playing this game. It made me kind of nervous when we were being observed.
  - **Student 3:** I felt comfortable playing Rummikub. It kind of reminded me of a board game I have played before.
- **What strategies did you decide to use to discard of your tiles?**
  - **Student 1:** In my tray, I lined up all the numbers with like numbers. So I put all my ones together, all my twos together, and so on. When I would see that I had enough tiles to start to make or make a sequence, I would make it in my tray before setting them down.
  - **Student 2:** I looked at the sequences and patterns that were already used by the other people playing, these examples gave me an idea of what patterns I should lay down.

    - **Student 3:** I made the patterns in my tray first so that I could make sure that they would work before playing them in the game. Sometimes my patterns didn't make sense so I had to retry.
- **Did you care about winning the game?**
    - **Student 1:** I wanted to win the game!
    - **Student 2:** I did not care if I won the game.
    - **Student 3:** I wanted to win!

Questionnaire 3

- **Question 1: Did you like when the instructor joined to play the game? Why**?
    - **Student 1**: Yes! I think that it was cool that she joined in.
    - **Student 2**: I really liked playing Battleship with her, it was fun.
    - **Student 3**: Yes, I thought she made the games more fun!
- **Question 2: Did you like having a choice in the game you could play?**
    - **Student 1:** Yes, I liked having a choice in the game. Battleship was my favorite game from the three, so I was glad we ended up playing it!
    - **Student 2:** The choice did not really matter to me. I like Battleship, but I wouldn't have minded playing the other games, either.
    - **Student 3:** Yes! I like when I can choose because then I can choose a game that interests me.

Questionnaire 4

Questions and Answers from Trial 3:

- **Did you like playing the games to practice math?**
    - **Student 1:** Yes! I think they were fun. I know they were chosen to help teach math, but when we were playing them, it was actually fun!
    - **Student 2:** Yes! Especially Battleship, I haven't learned a lot about the coordinate system before, but I think these helped me understand how to locate a certain point.
    - **Student 3:** Yes! I think that these games were fun to play! It didn't even seem like we were learning boring math.
- **What was your favorite part about the games?**
    - **Student 1:** I liked when we had a choice. I thought it was cool when we could choose which game we wanted to play and when we could make up the rules.
    - **Student 2:** I thought it was fun to play the Battleship game in partners. Then we could create our plan and work together.
    - **Student 3:** I loved everything about playing these games!
- **Do you think playing games related to the material you were learning in your math classes would help you better learn the material?**
    - **Student 1:** Yes! I think that playing games is a fun way to practice the math.
    - **Student 2:** Yes, I wish my math teachers used games in their classes. Then, math wouldn't be as boring.

    - **Student 3:** Yes, I really like playing the games. I think when I was playing the games I actually learned more than if the teacher had just told me the stuff or gave me a worksheet, like we always do in class.
- **Do you think that you were more focused on winning, on practicing and learning math, both, or neither?**
    - **Student 1:** I was not extremely focused on winning in the games. I mean, I wanted to win, but it was not a big deal if I didn't. I don't think I was entirely focused on the math part of the game, but I still did learn a lot even though I was not directly focused on the math.
    - **Student 2:** I think that I was just focused on following the rules of the games. I hadn't really thought about this before, but by following the rules, I guess I was practicing the math ideas. Cool!
    - **Student 3:** I wanted to win, but it wasn't my main focus during the game. I think I just focused on playing the game, if that makes sense. I think I learned a lot from the games

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Board Games that Align with 7th Grade Common Core

Standards for Mathematical Practice:

- **CCSS.Math.Practice.MP1** Make sense of problems and persevere in solving them.

- **CCSS.Math.Practice.MP2** Reason abstractly and quantitatively.

  - **Go:** This is a two-player board game. The board of this game is a 19 unit x 19 unit grid. Each player has stones or chips in a specific color. The main goal of the game is to cover a larger area with the stones than your opponent. The stones cannot be moved once placed on the board, unless the opponent captures them. This game requires players to use *strategic thinking*. In addition, players also need to use the concept of *surface area* in order to win this game.

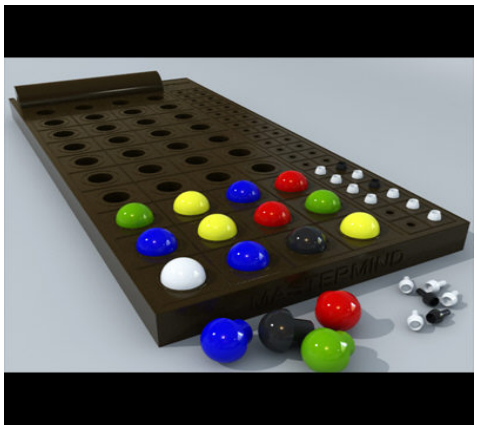
  - **Iota:** This is a card game that can be played with 2-4 players. There are 64 cards in the deck. Each card has three different properties: color, shape, and number. Each property has four different versions. Every player receives four different cards at the beginning of the game that may be played on the game grid. The main objective of this game is to create "lines" of 2-4 cards. Each line is a row of cards where color, shape, or number are all the same or different. The game ends when a player plays their last card. To win, the players must use *strategies* and be able to recognize *patterns*. (**Set** is a similar game.)

  - **Muggins:** This game utilizes *strategic thinking* and use of the *four operations: add, subtract, divide, and multiply* and the concept of *equations.* This game can be played with 2-4 players. Each player will roll 3 dice (either 6 sided or 12 sided, depending on what difficulty level they wish

to play.) Then, the player must form an equation using the numbers that they rolled. They can use any combination of the four operations. The goal is to create a number that will allow you to move ahead or block your opponents move on the board.

- **Othello:** This is a 2-player game played on a 8 unit x 8 unit game board. Each player gets 32 colored chips. The object of the game is to surround two ends of a row or column of your opponent's chips. When they are surrounded, the chips that you surrounded become yours instead of your opponents. The players have to think *strategically* in order to win. The player that plays all of their chips first wins.

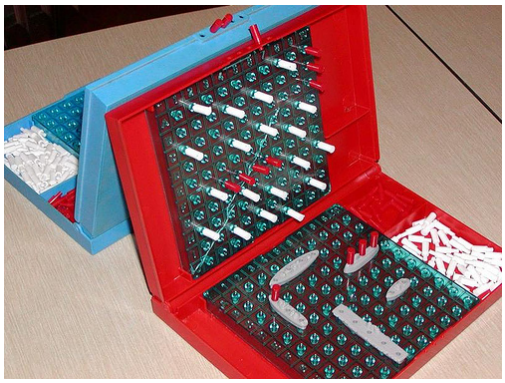
- **Pente:** This is another *strategy* and *tactical* game. The game is played on a grid board. The main objective of the game is to get five of your colored marbles or stones in a row. You can remove your opponent's stones if you enclose two stones on the ends; thus, creating space for your own pieces. The first player to either make a row of five stones or captures five pairs of the opponent's stones wins. Problem solving skills and the ability to use multiple strategies are essential in winning this game.



- **Mastermind:** This is a game of logic and reasoning. This game is intended to be used for two players. One of the player one creates a "code" on the peg board using colorful game pieces. Player two cannot see the code. Player two tries to replicate the pattern that player one created, with the help of clues from player 1 (in the form of white and red pegs). The goal is to create the matching code in less than 10 moves. This game requires a lot of *abstract* and *strategic thinking.*

- **Quirkle:** This board game is meant for 2-4 players. There are 108 blocks in the game with 6 different shapes in 6 different colors printed on them. Each player begins the game with 6 blocks. The goal is to create pairs that have one similar attribute (color or shape). Once a set is played, players can add on as long as the same attribute is repeated and no

duplicates are played. The players replenish their blocks after each turn. There are different score values for the plays. The game is over when the last block is played, the player with the highest amount of points wins. This is another *abstract strategy* game.

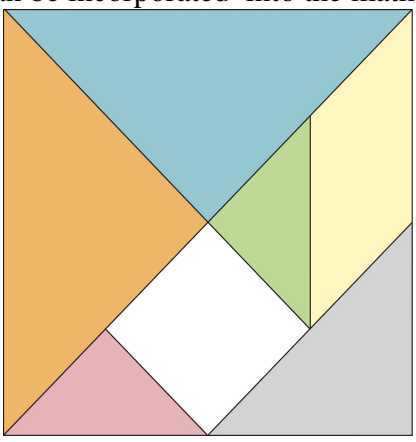


- **Battleship:** Battleship is a game that deals with the coordinate system. In this game, there are typically two players. The players each have their own battleship board. The top of the board is a place for the players to keep track of their own guesses; while the bottom of the board is where each player places their own battleships. Once the boards are set up, each player has to guess a point on the coordinate plane in which they thought a ship was located. A white peg is used to identify misses, while red pegs signify a hit. The players have to develop their own s*trategies* and think about what the best guess for a point would be. This game also helps students to demonstrate that they understand reading coordinate points, which is a very important skill that will be useful in future math courses.

- **CCSS.Math.Practice.MP3** Construct viable arguments and critique the reasoning of others.

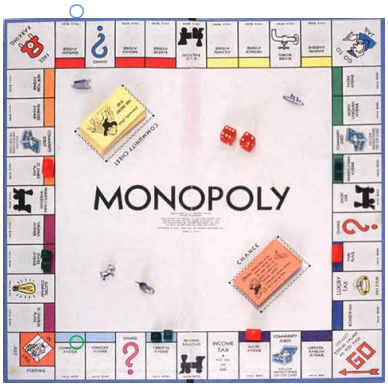
- **CCSS.Math.Practice.MP4** Model with mathematics.

    - **Tangrams:** Tangrams are manipulatives that can be incorporated into the math classroom. They can be bought or created with paper. They are shapes that can be combined together to form larger shapes. A board game can be created with tangrams. For instance, the teacher could create a board game where students draw cards with images of pre-drawn shapes that students must create out of tangrams. They will have to model different shapes out of tangrams. The difficulty of the shape that they model will determine the amount of spaces the person moves around the board. The first player to make it around the board wins.



- **CCSS.Math.Practice.MP5** Use appropriate tools strategically.

- **CCSS.Math.Practice.MP6** Attend to precision.
  - **Monopoly:** This game deals with buying properties and assets. It is a multiplayer game. The main goal of the game is to end up with the most money at the end of the game, after having bought properties and assets and paying bills and fees. This game offers players practice with real-world situations. Players must attend to precision when paying and collecting money to ensure that their accumulation of money is correct.



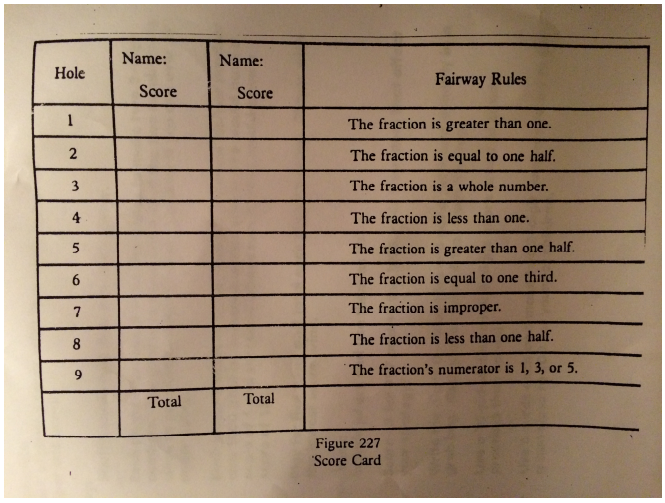
- **CCSS.Math.Practice.MP7** Look for and make use of structure.
  - **Iota (Repeated):** This is a card game that can be played with 2-4 players. There are 64 cards in the deck. Each card has three different properties: color, shape, and number. Each property has four different versions. Every player receives four different cards at the beginning of the game that may be played on the game grid. The main objective of this game is to create "lines" of 2-4 cards. Each line is a row of cards where color, shape, or number are all the same or different. The game ends when a player plays their last card. To win, the players must use *strategies* and be able to recognize *patterns*. (**Set** is a similar game.)

- **CCSS.Math.Practice.MP8** Look for and express regularity in repeated reasoning.

Grade 7 Common Core Math Standards:

Ratios and Proportional Relationships

- Analyze proportional relationships and use them to solve real-world and mathematical problems.



Hole	Name: Score	Name: Score	Fairway Rules
1			The fraction is greater than one.
2			The fraction is equal to one half.
3			The fraction is a whole number.
4			The fraction is less than one.
5			The fraction is greater than one half.
6			The fraction is equal to one third.
7			The fraction is improper.
8			The fraction is less than one half.
9			The fraction's numerator is 1, 3, or 5.
	Total	Total	

Figure 227
Score Card

  - ***Fraction Golf: This is a teacher made game. It is a game that is used to help students review and practice creating fractions. This game provides great background knowledge for fractions before more complex concepts are learned. This game is created to be a two player game. The game board is set up like a golf score card. There are "9 holes" that the players will play. At each hole, there is a different description of a fraction. For instance, it may say "The fraction is improper." At each hole, the students have two different colored di. One color represents the number that will be in the numerator, and the other di represents the number that is in the denominator. The students have to roll the dice as many times as needed in order to create a fraction that meets the description of the whole. The students score for the hole is the number of rolls it took to meet the requirements of the hole. At the end of the game, the student with the lowest score wins!

  - **CCSS.Math.Content.7.RP.A.1**: Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units.

  - **CCSS.Math.Content.7.RP.A.2**: Recognize and represent proportional relationships between quantities.

    - **CCSS.Math.Content.7.RP.A.2.a:** Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.

        - **CCSS.Math.Content.7.RP.A.2.b**: Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.

        - **CCSS.Math.Content.7.RP.A.2.c**: Represent proportional relationships by equations.

        - **CCSS.Math.Content.7.RP.A.2.d:** Explain what a point (x, y) on the graph of a proportional relationship means in terms of the situation, with special attention to the points (0, 0) and (1, r) where r is the unit rate.

    - **CCSS.Math.Content.7.RP.A.3**: Use proportional relationships to solve multistep ratio and percent problems. Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.

The Number System

- Apply and extend previous understandings of operations with fractions.

    - **CCSS.Math.Content.7.NS.A.1:** Apply and extend previous understandings of addition and subtraction to add and subtract rational numbers; represent addition and subtraction on a horizontal or vertical number line diagram.

        - **CCSS.Math.Content.7.NS.A.1.a:** Describe situations in which opposite quantities combine to make 0. *For example, a hydrogen atom has 0 charge because its two constituents are oppositely charged.*

- **CCSS.Math.Content.7.NS.A.1.b:** Understand $p + q$ as the number located a distance $|q|$ from p, in the positive or negative direction depending on whether q is positive or negative. Show that a number and its opposite have a sum of 0 (are additive inverses). Interpret sums of rational numbers by describing real-world contexts.

- **CCSS.Math.Content.7.NS.A.1.c:** Understand subtraction of rational numbers as adding the additive inverse, $p - q = p + (-q)$. Show that the distance between two rational numbers on the number line is the absolute value of their difference, and apply this principle in real-world contexts.

  - **No Thanks!**: This is a card game that can be played with 3-7 players. The game uses both chips and cards. Every chip has a value of -1 points. When it is a player's turn, they have two options: 1) lay a chip so that the face up card does not have to be picked up. 2) Pick up the face up card and any chip that has been laid on the card. This game requires players to do a lot of *mental math*. Most of the math is related to *adding increments of -1* (chips) to the face value of the card.

- **CCSS.Math.Content.7.NS.A.1.d:** Apply properties of operations as strategies to add and subtract rational numbers.

  - **4 Way Countdown:** This board game uses a unique board (as seen to the left). It can be played with up to 4 players. The object of the game is to be the first player to get all 10 of your pegs to be flipped up. Each turn, the player rolls 2 dice. Then, the player must add, subtract, divide, or multiply the numbers rolled. The sum, difference, quotient, or product that is formed is the number that the player flips up on the board. The player has to use *strategic thinking* in order to decide on what operation would benefit their state in the game the most. In addition, this game involves a lot of *mental math*.

- **CCSS.Math.Content.7.NS.A.2:** Apply and extend previous understandings of multiplication and division and of fractions to multiply and divide rational numbers.

  - **CCSS.Math.Content.7.NS.A.2.a:** Understand that multiplication is extended from fractions to rational numbers by requiring that operations continue to satisfy the properties of operations, particularly the distributive property, leading to products such as (-1)(-1) = 1 and the rules for multiplying signed numbers. Interpret products of rational numbers by describing real-world contexts.

  - **CCSS.Math.Content.7.NS.A.2.b:** Understand that integers can be divided, provided that the divisor is not zero, and every quotient of integers (with non-zero divisor) is a rational number. If p and q are integers, then $-(p/q) = (-p)/q = p/(-q)$. Interpret quotients of rational numbers by describing real-world contexts.

  - **CCSS.Math.Content.7.NS.A.2.c:** Apply properties of operations as strategies to multiply and divide rational numbers.

    - **24 Fractions Decimals:** This game consists of a deck of cards with 48 with different fractions on them and 48 with different decimals on them. Throughout the deck, cards are labeled with one, two, or three dots to indicate the difficulty of the fractions or decimals.

On each card there are 4 numbers (like the one in the picture). The object of the game is to create the number 24 by combining the all four of the numbers using the 4 operations. This game requires past knowledge about *fractions and decimals.* It also requires players to use A LOT of *mental math* to add, subtract, multiply, and divide rational numbers. Another application that can be used with this game would be to have

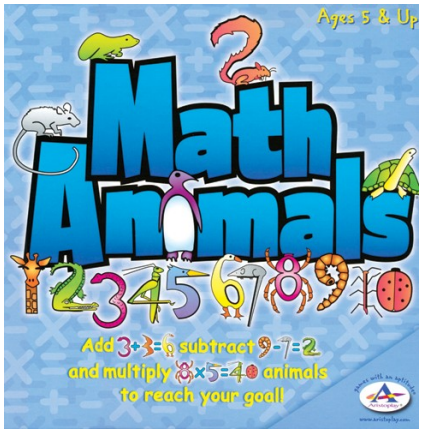
students create real-world story problems that are aligned with the operations they are using to establish the number 24.

- **24 integers:** The deck in this game consists of cards with 4 integers on them. The object of the game is to create the number 24 by adding, subtracting, multiplying, or dividing the numbers on the card. There are dots in the corners of each card that indicate the difficulty of the card. One dot is easy difficulty, two dots are medium difficulty, and three dots are hard difficulty. This came requires players to use a lot of *mental math* skills. In addition, the players have to have established an understanding of what the term *integer* means, and know how operations can be done with integers. Another application that can be used with this game would be to have students create real-world story problems that are aligned with the operations they are using to establish the number 24.

- **CCSS.Math.Content.7.NS.A.2.d:** Convert a rational number to a decimal using long division; know that the decimal form of a rational number terminates in 0s or eventually repeats.

- **CCSS.Math.Content.7.NS.A.3:** Solve real-world and mathematical problems involving the four operations with rational numbers.

  - **Math Animals:** This game is intended to allow students to practice their math skills. There are whole numbers on cards. The object of the game is to correctly add, multiply, subtract, or divide the numbers. There are six variations of the game that apply to six different ability levels of learning in math. The players travel around the gameboard and use the four operations to create "math animals" which represent a specific number. This game requires previous knowledge of the *four operations* and *mental math* skills.

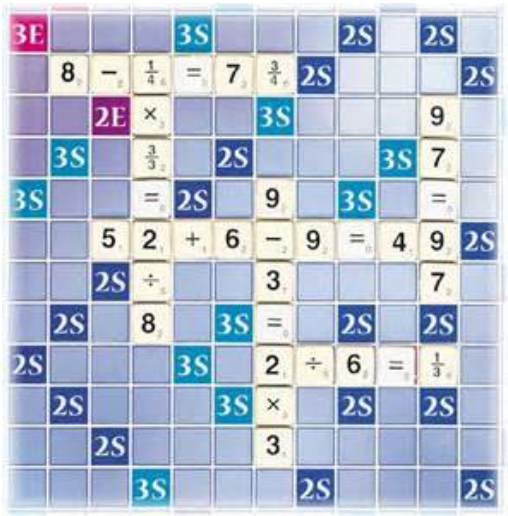


Expressions and Equations

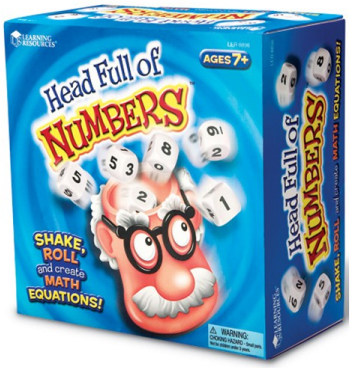
- Use properties of operations to generate equivalent expressions.

- **CCSS.Math.Content.7.EE.A.1**: Apply properties of operations as strategies to add, subtract, factor, and expand linear expressions with rational coefficients.

- **Math Dice:** This game focuses on *mental math,* creating *equations,* and using the *four operations.* Player 1 rolls two 12-sided dice. Then, all players work together to form a target number by adding or multiplying the two rolled numbers. Next, Player 2 rolls three of the 6-sided dice. Then, using the three numbers that were rolled, all players, individually, have to create an equation that adds, multiplies, subtracts, or divides the numbers to create a number that is as close as possible to the target number. Once the player has established a solution, they shout it out. The player who has formed a solution that is closest to the target number gets the point. This can be played with multiple players. I



- **Equate:** This game is very similar to the board game Scrabble; however, the tiles are numbers and operations instead of letters. The number tiles in the game are rational numbers. It can be played with 2-5 players. The goal of the game is to create equations across the board with the tiles. The equation must be complete and correct in order to be laid out on the board. Each symbol has a point value. On the board there are tiles that indicate that the point value of the symbols can be doubled, or tripled. The object of the game is to use all of the tiles and receive the highest score. (Another version of the game is called: **Smath**).



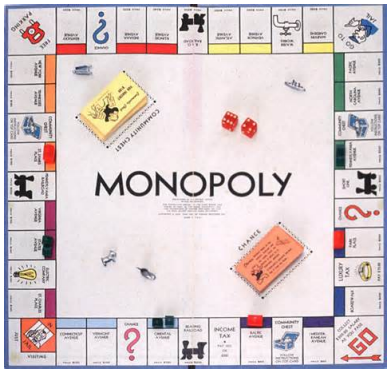
- **Head Full of Numbers:** For this game, three standard dice are put into the "head" which acts as the dice roller. Each turn, the player has to take the rolled dice and create and equation using the numbers rolled. The equation can use multiplication, division, addition, or subtraction. While the player is making equations, there is a hour glass counting down the time. The goal of the game is to make the most correct equations with the rolled numbers as possible. Each equation created gets a specific number of points. At the end of the game, the player with the most points is the winner. There are also other variations of the game that use more difficult dice to raise the difficulty of the game. Players must know how to write *equations* and use *mental math* in order to win the game.

- **CCSS.Math.Content.7.EE.A.2**: Understand that rewriting an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related.

- Solve real-life and mathematical problems using numerical and algebraic expressions and equations.

- **CCSS.Math.Content.7.EE.B.3:** Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies.

  - **Monopoly:** This game deals with buying properties and assets. It is a multiplayer game. The main goal of the game is to end up with the most money at the end of the game, after having bought properties and assets and paying bills and fees. This game offers players practice with real-world situations. Players must attend to precision when paying and collecting money to ensure that their accumulation of money is correct. The players have to calculate luxury tax and income tax within the game. Players also must add and subtract monetary quantities from their total money amount throughout the game as they end on specific spaces. For instance, they may have to pay or collect rent, buy houses or hotels, etc. The calculations in the game use mostly whole numbers and decimals (percents).



- **Mathopoly (Mathematical Opportunities Using Polynomials):** This board game is a spin off the game Monopoly. This game is intended to be used to help scaffold for the current math curriculum between grade 5 and 8. As players travel around the board, each square has a different "challenge on it." Throughout the game, there are activities and challenges that help students

practice *place value, adding, subtracting, and converting fractions, building geometric figures, using ordered pairs to determine a pattern, creating equations, exploring dice rolling probability, measurement, creating word problems, solve tangram puzzles, create balanced equations, use geoboards, make graphs, and practice academic language.* This game really covers a lot of the math curriculum. It is great to use for review. Throughout the game, students are constantly solving *multi-step* problems and using the *tools and materials strategically.*

- **PayDay:** This is a multiplayer game that deals primarily with real world situations that involve money. The goal of the game is to have the most money by the end of the period that is being played. Players have the option of buying spaces, buying lottery tickets, taking out loans, etc. Players have to pay down loans at the end of every month, and also get paid, The players have to use *mental math* skills to determine how much money to pay out or collect. Players may have more than one fee to pay out or collect throughout each turn. The situations in the game are applicable to real life.

- **CCSS.Math.Content.7.EE.B.4:** Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.

- ***Equate (Repeated):** This game is very similar to the board game Scrabble; however, the tiles are numbers and operations instead of letters. The number tiles in the game are rational numbers. It can be played with 2-5 players. The goal of the game is to create equations across the board with the tiles. The equation must be complete and correct in order to be laid out on the board. The game tiles do not include letter variables, but the teacher could cut out letter variables that could be used to create equations. Each symbol has a point value. On the board there are tiles that indicate that the point value of the symbols can be doubled, or tripled. The object of the game is to use all of the tiles and receive the highest score. (Another version of the game is called: **Smath**).

  - **CCSS.Math.Content.7.EE.B.4.a:**Solve word problems leading to equations of the form $px + q = r$ and $p(x + q) = r$, where p, q, and r are specific rational numbers. Solve equations of these forms fluently.

Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach.

- **CCSS.Math.Content.7.EE.B.4.b:** Solve word problems leading to inequalities of the form $px + q > r$ or $px + q < r$, where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem.

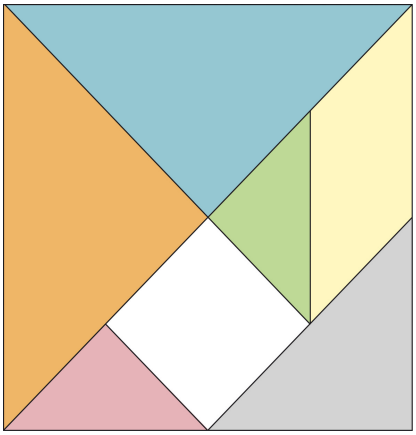
Geometry

- Draw construct, and describe geometrical figures and describe the relationships between them.

  - **Triominoes:** This game can be played with 2-8 players. The tiles in the game are This is game mainly deals with using *strategic thinking*. There are three numbers on each tile (located in the angle). The goal of the game is to place tiles next to each other so that only like numbers are touching. Placing the tiles requires players to analyze their own tiles and to create a game plan for how they are going to lay the tiles down. Although this game focuses more on strategy, it can also be used in geometry. This game helps demonstrate that triangles can be combined to form other shapes. If using this in a classroom to help teach geometry, the teacher may create a worksheet that goes along with the game, asking students to draw the different shapes that are created throughout the game. These may include rhombi, parallelograms, similar triangles, hexagons, and trapezoids.

    - **CCSS.Math.Content.7.G.A.1**: Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

- ***Tangrams (Repeat): Tangrams are manipulatives that can be incorporated into the math classroom. They can be bought or created with paper. They are shapes that can be combined together to form larger shapes. A board game can be created with tangrams. For instance, the teacher could create a board game where students draw cards with images of pre-drawn shapes that students must create out of tangrams. They will have to model different shapes out of tangrams. The difficulty of the shape that they model will determine the amount of spaces the person moves around the board. The first player to make it around the board wins. Another way to use tangrams would be to have students measure the side lengths of different tangrams and create a set of smaller or larger tangrams based on a certain scale factor. Then, the lengths and areas can be compared.



  - **CCSS.Math.Content.7.G.A.2:** Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.

  - **CCSS.Math.Content.7.G.A.3**: Describe the two-dimensional figures that result from slicing three-dimensional figures, as in plane sections of right rectangular prisms and right rectangular pyramids.

- Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.
  - **CCSS.Math.Content.7.G.B.4:** Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle.

- **CCSS.Math.Content.7.G.B.5**: Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure.

  - ***Angle Connect 4:** This game was developed by a teacher. It is designed for 2-4 players. The game board (as seen to the right) is composed descriptions of different types of angles. There is a deck of cards that is composed of pictures of different angles. Each student gets a deck of the cards. Students alternate turns, flipping over the top card of their deck. They have to look at the angle and correctly place it on the respective definition. The first player to complete a row, column, or diagonal with their pieces wins! Although this game does not directly help students practice this standard, it is necessary that students know about different angles in order to solve problems. Therefore, this game could be used to help students to review or establish background knowledge. The teacher could also make their own game board that would be more relevant to the standard. For instance, instead of definitions, the board could have different multistep problems, and the deck could have the answers (in equation form). Students would have to solve the problems in order to find which space to place their card on. Link to the game: **http://www.collaborativelearning.org/anglec4.pdf**

Angle Connect Four Game Board

an acute angle	more than an acute or a right angle	less than a reflex angle	more than a straight line	an obtuse angle	an acute angle
more than an obtuse angle	less than a straight line but more than a right angle	less than a right angle	a reflex angle	less than an obtuse or a right angle	more than an obtuse angle or a straight line
more than a right angle but less than a reflex angle	a reflex angle	an obtuse angle	less than an obtuse angle	an obtuse angle	less than a reflex angle
less than an obtuse angle but more than an acute angle	an acute angle	less than a reflex angle but more than an abtuse angle	less than a reflex angle or a straight line but more than a right angle	less than a right angle	a right angle

- **CCSS.Math.Content.7.G.B.6**: Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.

Statistics and Probability

- Use random sampling to draw inferences about a population.

- **CCSS.Math.Content.7.SP.A.1**: Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.

- **CCSS.Math.Content.7.SP.A.2:** Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions.

- Draw informal comparative inferences about two populations.

  - **CCSS.Math.Content.7.SP.B.3:** Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability.

  - **CCSS.Math.Content.7.SP.B.4:** Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations.

- Investigate chance processes and develop, use, and evaluate probability models.

  - **CCSS.Math.Content.7.SP.C.5**: Understand that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood. A probability near 0 indicates an unlikely event, a probability around 1/2 indicates an event that is neither unlikely nor likely, and a probability near 1 indicates a likely event.

- **CCSS.Math.Content.7.SP.C.6:** Approximate the probability of a chance event by collecting data on the chance process that produces it and observing its long-run relative frequency, and predict the approximate relative frequency given the probability.

- **CCSS.Math.Content.7.SP.C.7:** Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy.

  - **CCSS.Math.Content.7.SP.C.7.a:** Develop a uniform probability model by assigning equal probability to all outcomes, and use the model to determine probabilities of events.

  - **CCSS.Math.Content.7.SP.C.7.b:** Develop a probability model (which may not be uniform) by observing frequencies in data generated from a chance process.

- **Mathopoly (Mathematical Opportunities Using Polynomials) (Repeat):** This board game is a spin off the game Monopoly. This game is intended to be used to help scaffold for the current math curriculum between grade 5 and 8. As players travel around the board, each square has a different "challenge on it." Throughout the game, there are activities and challenges that help students practice place value, adding, subtracting, and converting fractions, building geometric figures, using ordered pairs to determine a pattern, creating equations, **exploring dice rolling probability**, measurement, creating word problems, solve tangram puzzles, create balanced equations, use geoboards, make graphs, and practice academic language. This game really covers a lot of the math curriculum. It is great to use for review. Throughout the game, students are constantly solving multi-step problems and

using the tools and materials strategically. The section of this game that deals with rolling a dice to determine the experimental and theoretical probability is applicable to this standard.

- ***M and M Probability:** This is not necessarily a game, but more an activity that teachers use to teach probability. Each student receives a mini pack of M and M's. They explore the sample space, and count how many of each colored M and M was in their bag. Then, they combine their findings with the rest of their classmates. Then, the students can explore the probabilities that were found.

- **This standard can also be practiced in other games that deal with cards and dice. Even if the game is not directly applicable, the teacher can have the students play the game, but also keep track of how many times each number is rolled, or how many times each card is pulled from the deck**

- **CCSS.Math.Content.7.SP.C.8**
  Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation.

  - **CCSS.Math.Content.7.SP.C.8.a:** Understand that, just as with simple events, the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs.

  - **CCSS.Math.Content.7.SP.C.8.b:** Represent sample spaces for compound events using methods such as organized lists, tables and tree diagrams. For an event described in everyday language (e.g., "rolling double sixes"), identify the outcomes in the sample space which compose the event.

  - **CCSS.Math.Content.7.SP.C.8.c:** Design and use a simulation to generate frequencies for compound events.

****** Means that the game has been adapted to better meet the needs of the standard.***

This cumulative list is of games are aligned to the Common Core State Standards for seventh grade mathematics. This list is intended to be a resource for seventh grade teachers. Teachers can use this list to justify how the games meet the standards and scaffold student learning. There are spaces after standards that did not have games aligned with them so that as teachers can add to the list as they develop lesson plans. They are able to add in games that they think could be aligned to those specific standards.